



CARLO GAVAZZI SPACE SpA

ACOP

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Issue: **1**

Date: **Oct. 2005**

Page **1** Of **23**

Title : **ACOP Software Verification Plan**

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CHANGE RECORD			
<i>ISSUE</i>	<i>DATE</i>	<i>CHANGE AUTHORITY</i>	<i>REASON FOR CHANGE AND AFFECTED SECTIONS</i>
1	October 2005	-	First Issue



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1. INTRODUCTION

1.1 SCOPE

This document is relevant to the ACOP project; particularly it refers to the development of the ACOP Software that will be installed on QM and FM. The document has been developed within the frame of the ACOP CDR activities.

1.2 PURPOSE

Purpose of the document is to define and describe the review, inspection tracing and test activities to be performed during the development life cycle of the ACOP-SW at Basic + Application SW level.

Figure 1.2-1 shows the verification approach adopted in the ACOP-SW life cycle. The validation process highlights that the ACOP-SW is not a standalone item, but it is an integral part of the ACOP HW/SW integrated unit.

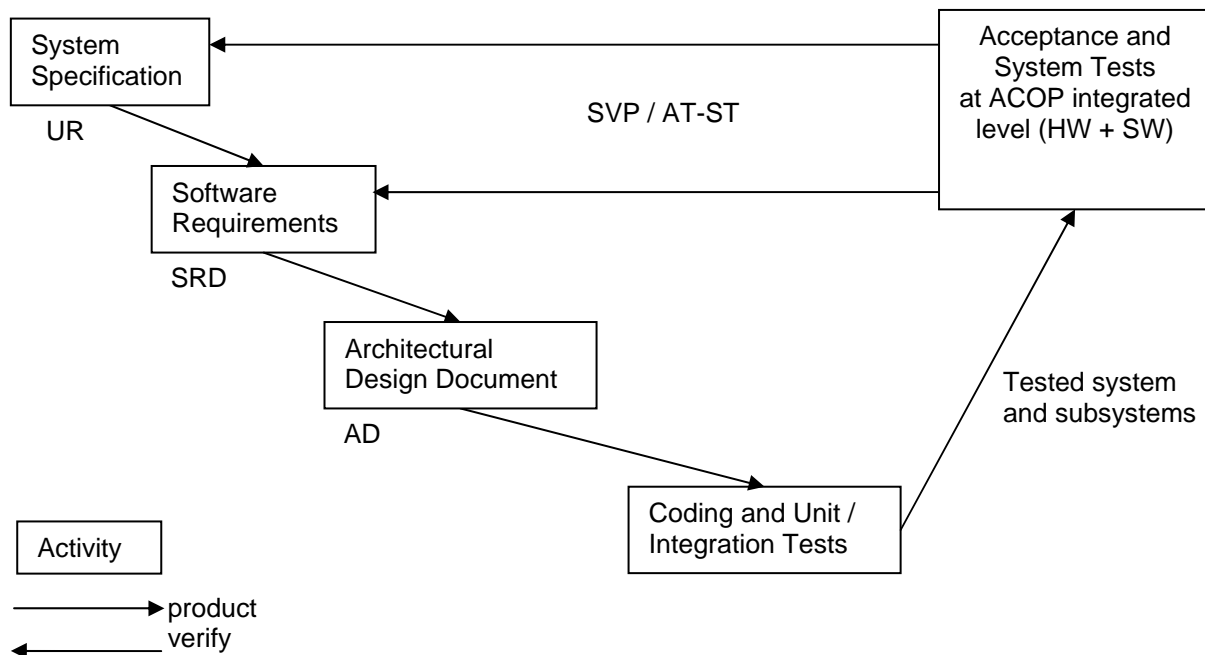


Figure 1.2-1 Software Life Cycle Verification Flow


1.3 DOCUMENT STRUCTURE

For the document structure, the table of contents reflects the recommendation of ESA reported in [RD3] DRD E16. So, the SVP content is split into three main sections:

Section 3: this section describes the methods and procedures used for formal reviews of software (such as technical reviews, walkthrough and software inspections)

Section 4: this section describes the procedures for tracing each part of the software phase input products to the corresponding phase outputs, and vice-versa.


Section 5: this section describes the test planning and test case specifications for the System tests (corresponding to ACOP-SW corresponding to ACOP-SW Software Requirements Document (SRD) and for the Acceptance tests (System Specification).

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The content of sections 3 and 4 is split in sections corresponding to the software life cycle phases of the ACOP-SW:

- UR : User Requirements phase
- SR : Software Requirements phase
- AD: Architectural Design phase

Test Procedures and Test Reports are not included in this document, but in the specific documents corresponding to DRD E11 and DRD 12 of [RD3].


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2. DOCUMENTS

2.1 APPLICABLE DOCUMENT

AD	Doc. Number	Issue / Date	Rev.	Title / Applicability
1	SSP 52000-IDD-ERP	D / 6.08.03		EXpedite the PROcessing of Experiments to Space Station (EXPRESS) Rack Payloads Interface Definition Document
2	NSTS/ISS 13830	C / 01.12.1996		Implementation Procedures for Payloads System Safety Requirements – For Payloads Using the STS & ISS.
3	JSC 26493	17.02.1995		Guidelines for the preparation of payload flight safety data packages and hazard reports.
4	SSP 50004	April 1994		Ground Support Equipment Design requirements
5	SSP-52000-PDS	March 1999	B	Payload Data Set Blank Book
6	SSP 52000-EIA-ERP	February 2001	A	Express Rack Integration Agreement blank book for Express Rack payload
7	GD-PL-CGS-001	3 / 17.03.99		Product Assurance & Rams Plan
8	SSP 52000 PAH ERP	November 1997		Payload Accommodation Handbook for EXPRESS Rack
9	SSP 50184	D / February 1996		Physical Media, Physical Signaling & link-level Protocol Specification for ensuring Interoperability of High Rate Data Link Stations on the International Space Program
10	SSP 52050	D / 08.06.01		S/W Interface Control Document for ISPR ***ONLY FOR HRDL, SECTION 3.4 ***
11	ECSS-E-40	A / April 1999	13	Software Engineering Standard
12	AMS02-CAT-ICD-R04	29.08.2003	04	AMS02 Command and Telemetry Interface Control document. Section AMS-ACOP Interfaces
13	SSP 52000-PVP-ERP	Sept. 18, 2002	D	Generic Payload Verification Plan EXpedite the PROcessing of Experiments to Space Station (EXPRESS) Rack Payloads
14	NSTS 1700.7B	Rev. B Change Packet 8 / 22.08.00		Safety Policy and Requirements for Payloads using the STS
15	NSTS 1700.7B Addendum	Rev. B Change Packet 1 / 01.09.00		Safety Policy and Requirements for Payloads using the International Space Station
16	SSP 52005	Dec. 10, 1998		Payload Flight equipment requirements and guidelines for safety critical structures
17	NSTS 18798B	Change Packet 7 10.00		Interpretation of NSTS Payload Safety Requirements
18	MSFC-HDBK-527	15.11.86	E	Materials selection list for space hardware systems Materials selection list data
19	GD-PL-CGS-002	1 / 12.02.99		CADM Plan
20	GD-PL-CGS-004	2 / 07.04.03		SW Product Assurance Plan
21	GD-PL-CGS-005	2 / 09.05.03		SW CADM Plan
22	ACP-PL-CGS-002	1 / 28.07.2004		ACOP PA Plan
23	ACP-SQ-CGS-001	1 / January 2005		Software Requirements Document

Table 2.1-1 Applicable Documents

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2.2 REFERENCE DOCUMENT

RD	Doc. Number	Issue / Date	Rev.	Title
1	GPQ-MAN-02	1		Commercial, Aviation and Military (CAM) Equipment Evaluation Guidelines for ISS Payloads Use
2	BSSC (96)2	1 / May 96		Guide to applying the ESA software engineering standards to small software projects
3	GPQ-MAN-01	2 / December 98		Documentation Standard for ESA Microgravity Projects
4	MS-ESA-RQ-108	1 / 28 Sept. 2000		Documentation Requirements For Small And Medium Sized MSM Projects
5	PSS-05			Software Engineering Standards
6	GPQ-010	1 / May 95	A	Product Assurance Requirements for ESA Microgravity Payload. Including CN 01.
7	GPQ-010-PSA-101	1		Safety and Material Requirements for ESA Microgravity Payloads
8	GPQ-010-PSA-102	1		Reliability and Maintainability for ESA Microgravity Facilities (ISSA). Including CN 01
9	ECSS-Q-60-11A	1 / 7 Sept. 2004		De-rating and End-of-life Parameter Drifts – EEE Components
10	ACP-RP-CGS-002	2 / October 2005		ACOP Operational Analysis Report
11	ACP-RP-CGS-003	2 / October 2005		ACOP Design Report
12	ACP-RP-CGS-004	2 / October 2005		ACOP Electrical Analysis and Design Report
13	ACP-RP-CGS-005	2 / October 2005		ACOP Structural Analysis and Design Report
14	ACP-RP-CGS-006	2 / October 2005		ACOP Thermal Analysis and Design Report
15	ACP-TN-CGS-001	2 / October 2005		ACOP FMECA and SPF List
16	ACP-PL-CGS-004	1 / January 2005		ACOP Verification Plan
17	ACD-Requirements-Rev-BL	September 2005	Base line	ACOP Common Design Requirements Document

Table 2.2-1 Reference Documents

 CARLO GAVAZZI SPACE SpA	ACOP	Doc N°: ACP-PL-CGS-009
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2.3 DEFINITIONS AND ACRONYMS

A

AAA	Avionics Air Assembly
ABCL	As-Built Configuration data List
ACOP	AMS-02 Crew Operation Post
ACOP-SW	ACOP Flight Software
ADP	Acceptance Data Package
AMS-02	Alpha Magnetic Spectrometer 02
APS	Automatic Payload Switch
AR	Acceptance Review
ASI	Agenzia Spaziale Italiana (<i>Italian Space Agency</i>)
ATP	Authorization To Proceed

B

BC	Bus Coupler
BDC	Baseline Data Collection
BDCM	Baseline Data Collection Model

C

CAD	Computer Aided Design
CCB	Configuration Control Board
CCSDS	Consultative Committee on Space Data Standards (standard format for data transmission)
C&DH	Command & Data Handling
CDR	Critical Design Review
CGS	Carlo Gavazzi Space
CI	Configuration Item
CIDL	Configuration Item data List
CM	Configuration Management
COTS	Commercial Off The Shelf
cPCI	CompactPCI (Euro Card sized standard interface to the PCI)
CSCI	Computer Software Configuration Item
CSIST	Chung Shan Institute of Science and Technology

D

DCL	Declared Components List
DIL	Deliverable Items List
DIO	Digital Input / Output
DML	Declared Materials List
DMPL	Declared Mechanical Parts List
DPL	Declared Processes List
DRB	Delivery Review Board
DRD	Document Requirements Description

E

EEE	Electrical, Electronic & Electromechanical
EGSE	Electrical Ground Support Equipment
EM	Engineering Model
ER	EXPRESS Rack
ERL	EXPRESS Rack Laptop
ERLC	EXPRESS Rack Laptop Computer
ERLS	EXPRESS Rack Laptop Software
EMC	Electro-Magnetic Compatibility
ESA	European Space Agency
EXPRESS	EXPedite the PROcessing of Experiments to Space Station

F

FEM	Finite Element Model
FFMAR	Final Flight Model Acceptance Review
FLASH	Rewriteable persistent computer memory
FM	Flight Model
FMECA	Failure Modes, Effects & Criticalities Analysis
FPGA	Field Programmable Gate Array

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FSM Flight Spare Model

G

GIDEP Government Industry Data Exchange Program
GSE Ground Support Equipment

H

HCOR HRDL Communications Outage Recorder
HD Hard Drive
HDD Hard Disk Drive
HRDL High Rate Data Link
HRFM High Rate Frame Multiplexer
HW Hardware

I

ICD Interface Control Document
I/F Interface
IRD Interface Requirements Document
ISPR International Space-station Payload Rack
ISS International Space Station

J

JSC Johnson Space Center

K

KIP Key Inspection Point
KSC Kennedy Space Center
KU-Band High rate space to ground radio link

L

LAN Local Area Network
LCD Liquid Crystal Display
LFM Low Fidelity Model
LRDL Low Rate Data Link

M

MDL Mid-Deck Locker
MGSE Mechanical Ground Support Equipment
MIP Mandatory Inspection Point
MMI Man Machine Interface
MPLM Multi-Purpose Logistic Module
MRDL Medium Rate Data Link

N


NA Not Applicable
NASA National Aeronautics and Space Administration
NCR Non Conformance Report
NDI Non Destructive Inspection
NRB Non-conformance Review Board
NSTS National Space Transportation System (Shuttle)

O

OLED Organic Light-Emitting Diode
ORU Orbital Replacement Unit

P

PA Product Assurance
PCB Printed Circuit Board
PCI Peripheral Component Interconnect (personal computer bus)
PCS Personal Computer System
PDR Preliminary Design Review
PEHB Payload Ethernet Hub Bridge
PEHG Payload Ethernet Hub Gateway

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PFMAR Preliminary Flight Model Acceptance Review
 PLMDM Payload Multiplexer De-Multiplexer
 PMC PCI (Peripheral Component Interconnect) Mezzanine Card
 PMP Parts, Materials & Processes
 PROM Programmable Read Only Memory
 PS Power Supply

Q

QM Qualification Model

R

RFA Request For Approval
 RFD Request For Deviation
 RFW Request For Waiver
 RIC Rack Interface Controller
 ROD Review Of Design
 ROM Read Only Memory
 RX Reception

S

SATA Serial Advanced Transfer Architecture (disk interface)
 S-Band Space to ground radio link
 SBC Single Board Computer
 SC MDM Station Control Multiplexer De-Multiplexer
 ScS Suitcase Simulator
 SDD Solid-state Disk Drive
 SIM Similarity Assessment
 SIO Serial Input Output
 SOW Statement Of Work
 SPF Single Point Failure
 SRD Software Requirements Document
 STS Space Transportation System (Shuttle)
 SW Software

T

TBC To Be Confirmed
 TBD To Be Defined
 TBDCM Training & Baseline Data Collection Model
 TBDCMAR TBDCM Acceptance Review
 TBP To Be Provided
 TCP/IP Transmission Control Protocol / Internet Protocol
 TFT Thin Film Transistor
 TM Telemetry
 TRB Test Review Board
 TRR Test Readiness Review
 TRM Training Model
 TX Transmission

U

UIP Utility Interface Panel
 UMA Universal Mating Assembly
 USB Universal Serial Bus

#

100bt Ethernet 100Mbit Specification
 1553 Reliable serial communications bus

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3. VERIFICATION ACTIVITIES

3.1 UR PHASE

3.1.1 VERIFICATION ACTIVITIES OVERVIEW

3.1.1.1 ORGANISATION

The SV process is carried out by a Software Verification team, which is made up of:

- ACOP-SW System Engineer
- ACOP Product Assurance Manager
- Software engineer(s)

The organization is summarized by the scheme shown in Figure 3.1-1.

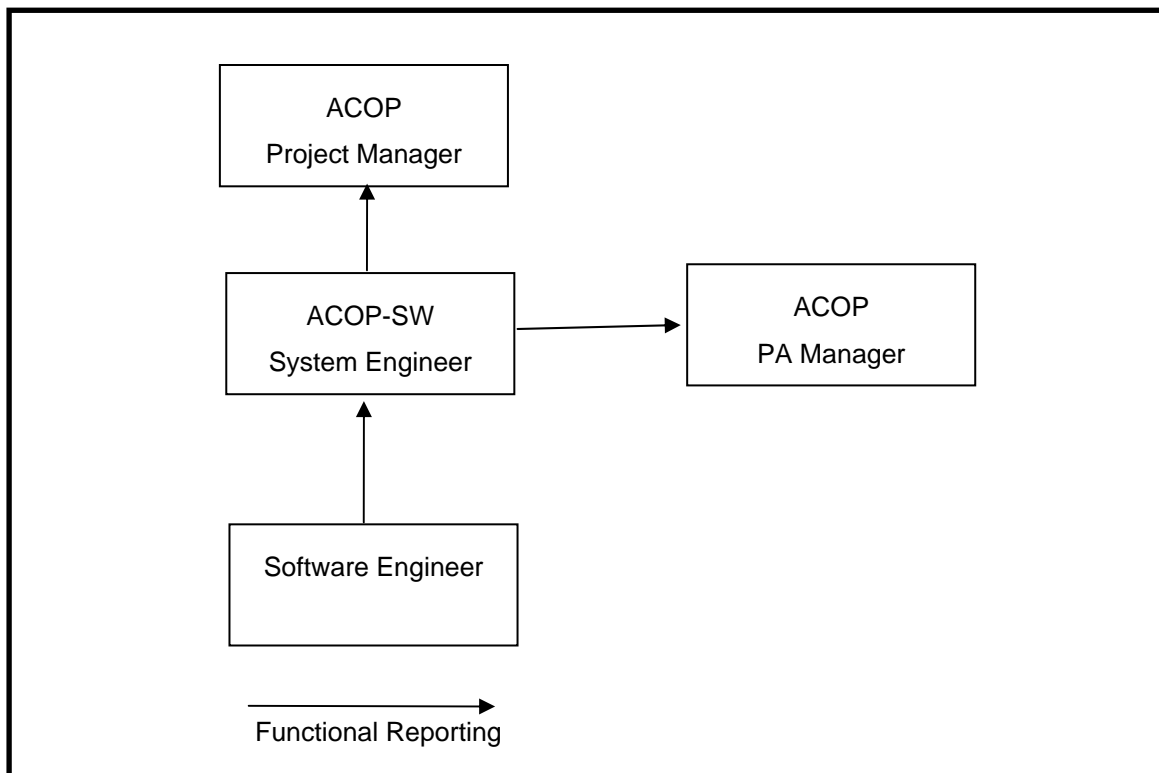


Figure 3.1-1 SW Verification Team Organization

3.1.1.2 MASTER SCHEDULE

The master schedule of software is a part of the overall ACOP schedule.

3.1.1.3 RESOURCE SUMMARY

No specific software tools are used in the User Requirement phase. Software User requirements are included in a Microsoft Word document.

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3.1.1.4 TOOLS, TECHNIQUES AND METHODS

The methods will be the use of:

- Traceability Matrix: User Requirements Vs Software Requirements and applicable documentation.

3.1.2 VERIFICATION AND VALIDATION ADMINISTRATIVE PROCEDURES

3.1.2.1 ANOMALY REPORTING AND RESOLUTION

The system for the anomaly reporting and resolution is described in the ACOP PA Plan [AD22].

3.1.2.2 TASK ITERATION POLICY

The procedure used for task iteration (i.e. for defining whether a task should be repeated when a change has been made) is defined [AD22].

3.1.2.3 DEVIATION POLICY

The Program Manager and Product Assurance Manager shall authorize any deviation from this plan.

3.1.2.4 CONTROL PROCEDURES

The procedure used for configuration management of SVV products is defined in [AD23].

3.1.2.5 STANDARDS, PRACTICES AND CONVENTIONS

The standards are listed below:

- ESA PSS-05-0 [RD5]
- CGS SW Product Assurance Plan [AD20]
- Tailored ECSS-E-40 [AD11]

3.1.3 VERIFICATION AND VALIDATION ACTIVITIES

3.1.3.1 TRACEABILITY

User requirements will be traced to upper level requirements (ACOP applicable documentation). Traceability of UR requirements with regard to upper level requirements is described in section 4.1

3.1.3.2 FORMAL PROOFS

No formal proof of SR is foreseen.

3.1.3.3 REVIEWS

No internal reviews and audits for pure quality assurance purposes will be performed. During the overall design and development cycle, the ACOP-SW development team will have periodic internal technical reviews for the purpose of reporting status and problems to the ACOP PM and PA Managers.

3.1.4 VERIFICATION AND VALIDATION REPORTING

The Traceability Matrices will be reported in a separate document.

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3.2 SR PHASE

3.2.1 VERIFICATION ACTIVITIES OVERVIEW

3.2.1.1 ORGANISATION

The SV process is carried out by a SV team, which is made up of:

- ACOP-SW System Engineer
- ACOP Product Assurance Manager
- Software engineer(s)

The organization is summarized by the scheme shown in Figure 3.2-1

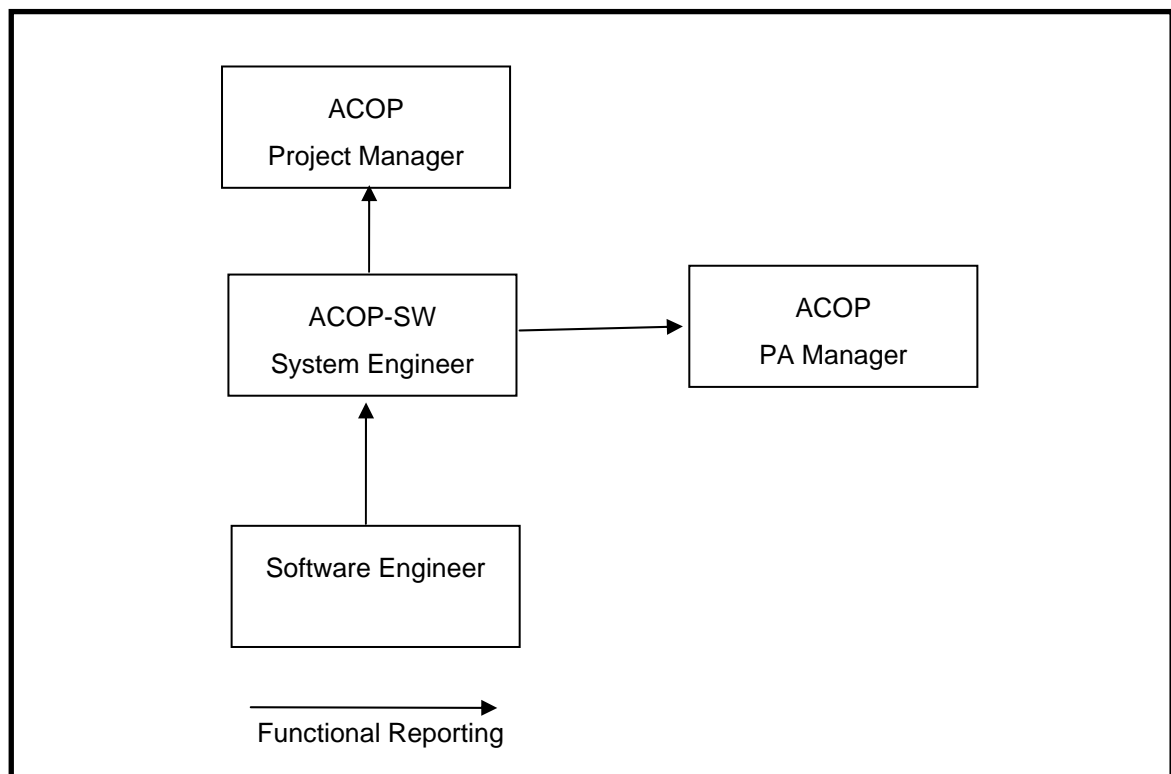


Figure 3.2-1 SW Verification Team Organization

3.2.1.2 MASTER SCHEDULE

The master schedule of software is a part of the overall ACOP schedule.

3.2.1.3 RESOURCE SUMMARY

The software tool to support SVV during the Software Requirement phase is Microsoft EXCEL.

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3.2.1.4 TOOLS, TECHNIQUES AND METHODS

The methods will be the use of:

- Traceability Matrices:
 - User Requirements Vs Software Requirements.
 - Software Requirements Vs User Requirements.

3.2.2 VERIFICATION AND VALIDATION ADMINISTRATIVE PROCEDURES

3.2.2.1 ANOMALY REPORTING AND RESOLUTION

The system for the anomaly reporting and resolution is described in the ACOP PA Plan [AD22]

3.2.2.2 TASK ITERATION POLICY

The procedure used for task iteration (i.e. for defining whether a task should be repeated when a change has been made) is defined [AD22].

3.2.2.3 DEVIATION POLICY

Any deviation from this plan shall be authorised by the Program Manager and Product Assurance Manager.

3.2.2.4 CONTROL PROCEDURES

The procedure used for configuration management of SVV products is defined in [AD23].

3.2.2.5 STANDARDS, PRACTICES AND CONVENTIONS

The standards are listed below:

- ESA PSS-05-0 [RD5]
- CGS SW Product Assurance Plan [AD20]
- Tailored ECSS-E-40 [AD11]

3.2.3 VERIFICATION AND VALIDATION ACTIVITIES

3.2.3.1 TRACEABILITY

SRD requirements will be traced to user requirements. The Traceability Matrix Template is described in section 4.2

3.2.3.2 FORMAL PROOFS

No formal proof of SR is foreseen.

3.2.3.3 REVIEWS

No internal reviews and audits for pure quality assurance purposes will be performed. During the overall design and development cycle, the ACOP-SW development team will have periodic internal technical reviews for the purpose of reporting the work package status/problems to the ACOP PM and PA Managers.

3.2.4 VERIFICATION AND VALIDATION REPORTING

The Traceability Matrices will be reported a separate document.

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3.3 ADDD PHASE

3.3.1 VERIFICATION ACTIVITIES OVERVIEW

3.3.1.1 ORGANISATION

The SV process is carried out by a SV team, which is made up of:

- ACOP-SW System Engineer
- ACOP Product Assurance Manager
- Software engineer(s)
- Software librarian

The organization is summarized by the scheme shown in Figure 3.3-1

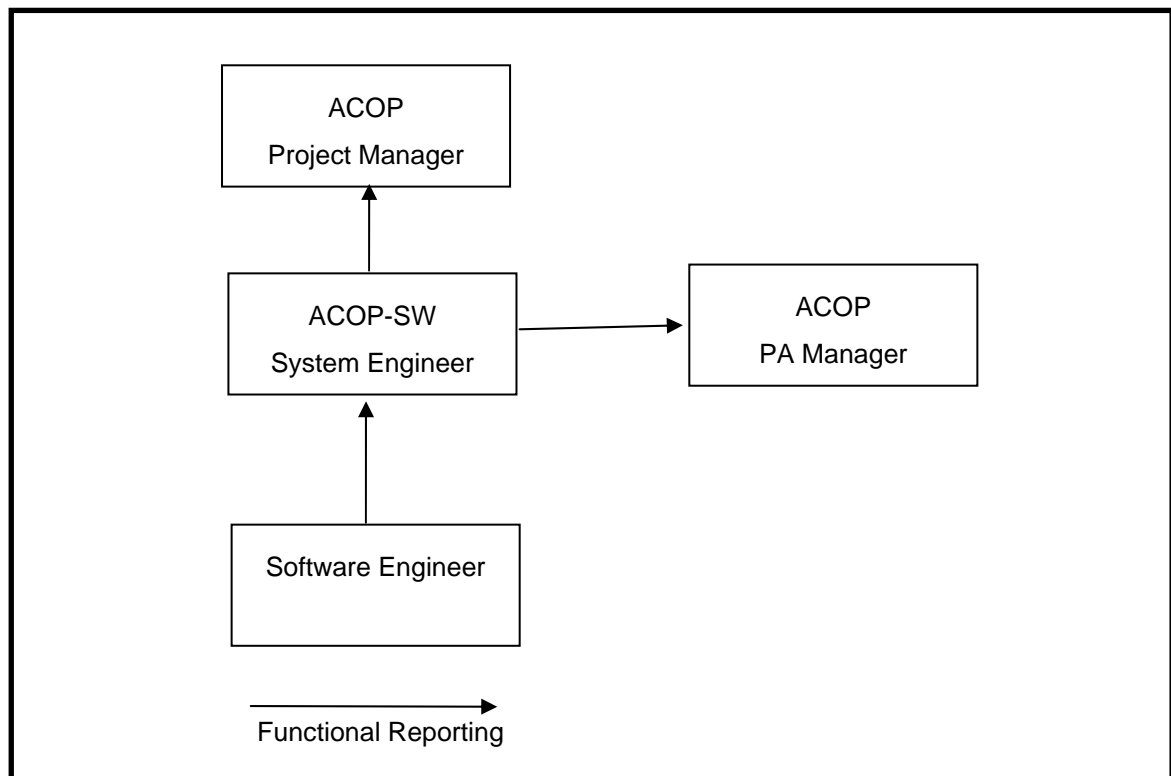



Figure 3.3-1 SW Verification Team Organization

3.3.1.2 MASTER SCHEDULE

The master schedule of software is a part of the overall ACOP schedule.

3.3.1.3 RESOURCE SUMMARY

- Hardware:
 - Software Development System: LINUX cross development environment
 - Integration Development System: ACOP/LFM
 - Acceptance System: TBD
- Software:
 - LINUX cross development environment

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3.3.1.4 TOOLS, TECHNIQUES AND METHODS

The methods will be the use of:

- Traceability Matrices:
 - Architectural Design Vs Software Requirements.
 - Software Requirements Vs Architectural Design.
 - C modules Vs Architectural Design
 - Architectural Design Vs C modules

3.3.2 VERIFICATION AND VALIDATION ADMINISTRATIVE PROCEDURES

3.3.2.1 ANOMALY REPORTING AND RESOLUTION

The system for the anomaly reporting and resolution is described in the ACOP PA Plan [AD22]

3.3.2.2 TASK ITERATION POLICY

The procedure used for task iteration (i.e. for defining whether a task should be repeated when a change has been made) is defined [AD22].

3.3.2.3 DEVIATION POLICY

The Program Manager and Product Assurance Manager shall authorize any deviation from this plan.

3.3.2.4 CONTROL PROCEDURES

The procedure used for configuration management of SVV products is defined in the ACOP CADM Plan [AD23].

3.3.2.5 STANDARDS, PRACTICES AND CONVENTIONS

The standards are listed below:

- ESA PSS-05-0 [RD5]
- CGS SW Product Assurance Plan [AD20]
- Tailored ECSS-E-40 [AD11]

3.3.3 VERIFICATION AND VALIDATION ACTIVITIES

3.3.3.1 ANALYSES

The following analyses will be performed: TBD

3.3.3.2 TRACEABILITY

AD software components will be traced to SRD requirements. The Traceability Matrix Template is described in section 4.3.

3.3.3.3 FORMAL PROOFS

No formal proof of AD is foreseen.

3.3.3.4 REVIEWS


No internal reviews and audits for pure quality assurance purposes will be performed.

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During the overall design and development cycle, the ACOP-SW development team will have periodic internal technical reviews for the purpose of reporting the work package status/problems to the ACOP PM and PA Managers.

3.3.4 VERIFICATION AND VALIDATION REPORTING

The Traceability Matrices will be reported a separate document.

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4. TRACING

4.1 UR PHASE

The Tables describing User Requirements include, in the second column, the upper level requirement (from PDRD or applicable documents).

4.2 SR PHASE

Traceability matrices will be included in the ACOP-SRD document [AD23].

The following is the template for Software Requirements Vs User Requirements:

Software requirements <Software_Requirement_Document>	User requirements <System_Specification>

The following is the template for User Requirements Vs Software Requirements:

User requirements < System_Specification >	Software requirements <Software_Requirement_Document>

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4.3 ADDD PHASE

The following is the Traceability Matrix from Architectural Design Vs Software Requirements:

AD component (*) <Architectural_Design_Document>	Software Requirement (**) <Software_Requirement_Document>

* ACOP-SW component (Task or C-library)

** Textual requirement number.

Table 4.3-1 Traceability Matrix from Architectural Design Vs Software Requirements

Matrix from Software Requirements Vs Architectural Design:

Software Requirement(*) <Software_Requirement_Document>	AD component(**) <Architectural_Design_Document>

* Textual Requirement number

** ACOP-SW component (Task or C-library)

Table 4.3-2 Matrix from Software Requirements Vs Architectural Design

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5. TEST ACTIVITIES

5.1 ACCEPTANCE TEST PLAN

This plan defines the acceptance test activities to be performed on the ACOP software.

ACOP-SW is not accepted as stand-alone SW, but as integral part of the ACOP system. ACOP-SW tests will be performed at system level on the ACOP QM and FM.

5.1.1 TEST ITEMS

The item to be tested is the ACOP Software as defined in the SRD [AD23].

5.1.2 FEATURES TO BE TESTED

All the requirements of the ACOP_SW, as defined in the System Specification and SRD, are verified.

The verification of the UR requirements is done by:

1. Functional test, i.e. by using a test procedure and comparing expected results with obtained results.
2. Review of design, i.e. by verifying that the requirement is implemented in the Architectural Design Document and in general, in the SW documentation.
3. Inspection of the SW code listings.

For all verifications the relevant acceptance procedure will be described in the ACOP-SW Test Procedure Document.

5.1.3 FEATURES NOT TO BE TESTED

TBD

5.1.4 APPROACH

For the acceptance test, the ACOP-SW will be downloaded into the ACOP hardware (QM and FM models), which is the target hardware. The following acceptance test campaigns are foreseen:

1. Acceptance of the ACOP QM model
2. Acceptance of the ACOP FM model

5.1.5 ITEM PASS/FAIL CRITERIA

Each test case specifies the relevant pass/fail criteria

5.1.6 RESUMPTION CRITERIA

The tests should be executed in sequence.

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5.1.7 TEST DELIVERABLES

At the end of testing, a "Test Report" will be prepared, collecting all the "test input commands" and "test output results". The record of acceptance tests (with customer signature) will be included in the ACOP-SW Test Reports.

Anomaly reporting and resolution is performed by means of Software Problem Reports, Software Change Requests and Software Modification Reports, according to procedure TBD of the ACOP PA Plan [AD22]

5.1.8 TESTING TASKS

To start the acceptance tests, the ACOP-SW shall be downloaded to ACOP.

5.1.9 ENVIRONMENTAL NEEDS

Acceptance System: ACOP Hardware and ACOP/GSE

5.1.10 STAFFING AND TRAINING NEEDS

TBD

5.1.11 SCHEDULE

TBD

5.1.12 RISKS AND CONTINGENCIES

None.

5.1.13 APPROVALS

Approvals are shown on the cover page of the plan.